Micro-Packaging Technology (MPT) Used to Reduce Size and Weight of Large Electronic Systems, and Develop New Architectures for Future Designs

D. Uyemura, R. Williams, P. Hudson

October 12, 1997

ISHM '97 Advanced Technology Workshop on 3D Packaging

HUGHES AIRCRAFT

MADCAP

INTERNATIONAL SOCIETY FOR HYBRID MICROELECTRONICS

MADCAP
Mosaic Array Data Compression and Processing

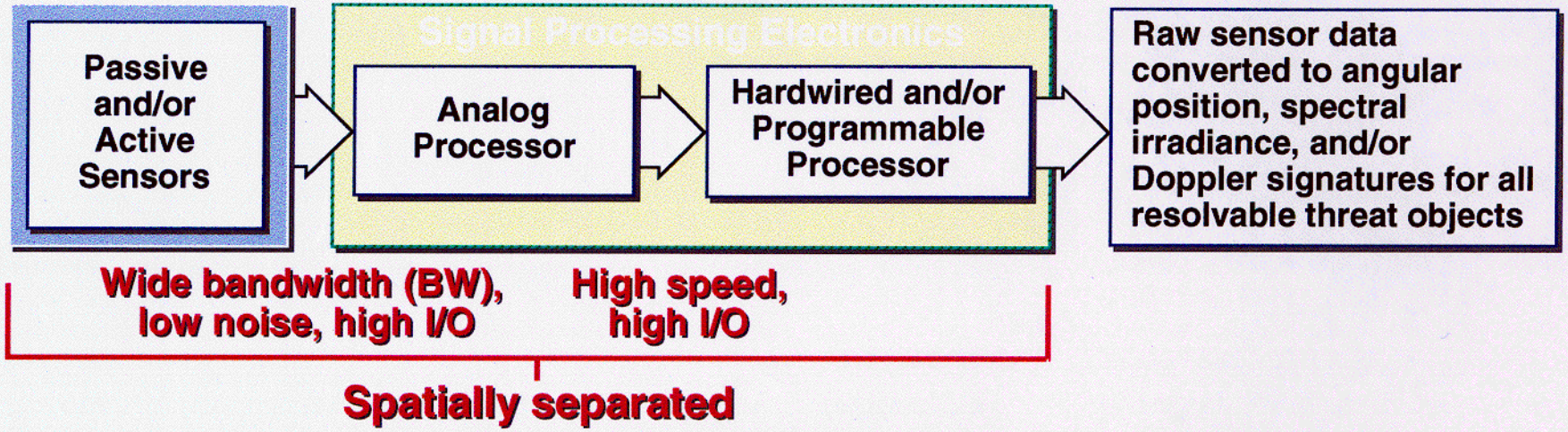
Hughes Aircraft Company
Electro-Optical Systems (El Segundo, CA)

Customer:	**U.S. Army Space and Strategic Defense Command**
POC:	**Osborne Milton**
Title of effort:	**Mosaic Array Data Compression and Processing (MADCAP)**
Contract no.:	**DASG60-90-C-0135**

Sensor System Benefits from 3D Packaging

HUGHES AIRCRAFT

Typical Sensor System

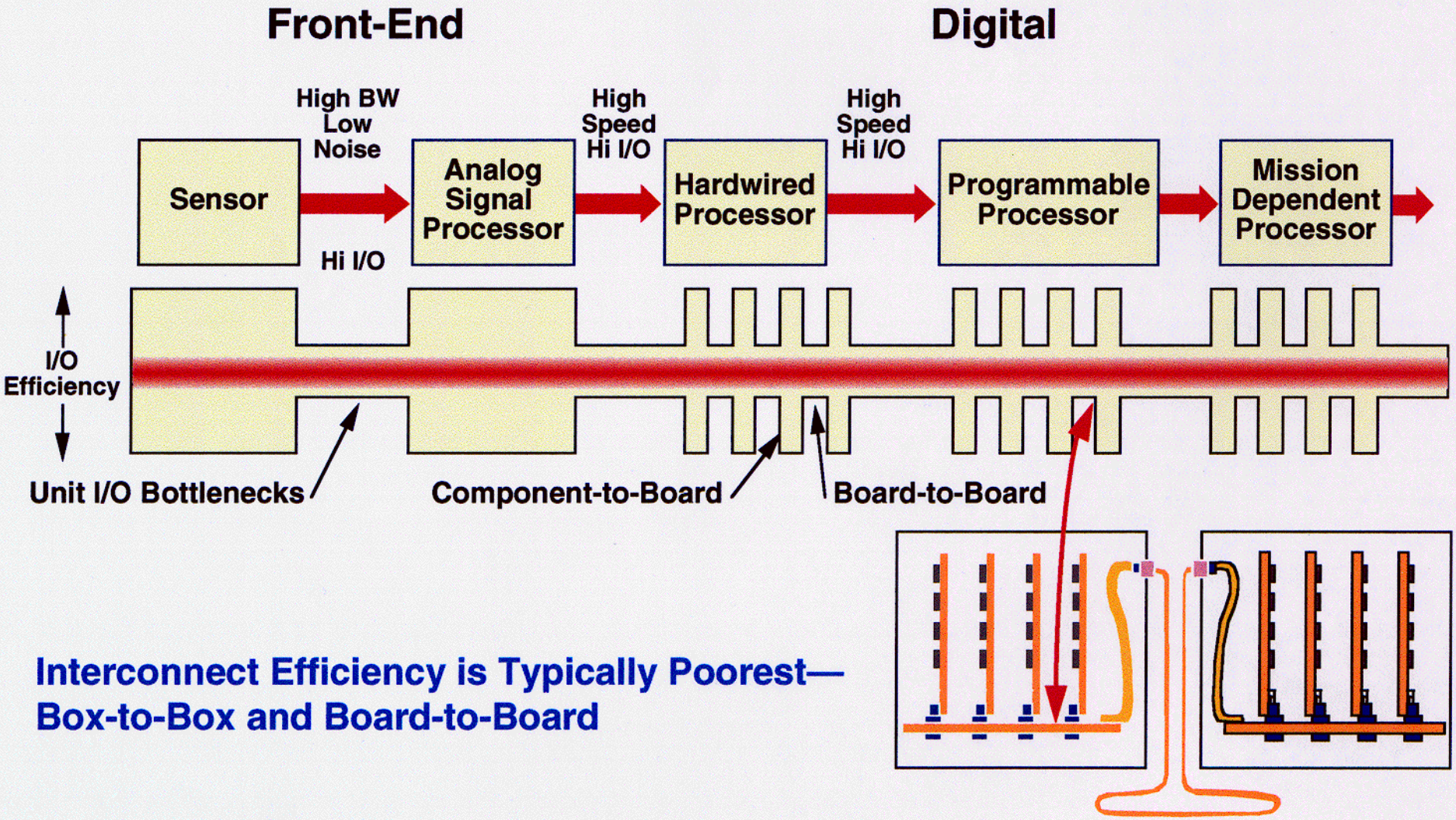


- **High I/O count and long signal paths between units, boards, and components**
  - Long signal paths increase power dissipation (CV^2F power loss), resistance
  - Cables and backplanes add complexity/weight and can degrade system performance (noise)

MADCAP

Why 3D Packaging for Sensor Systems

HUGHES AIRCRAFT



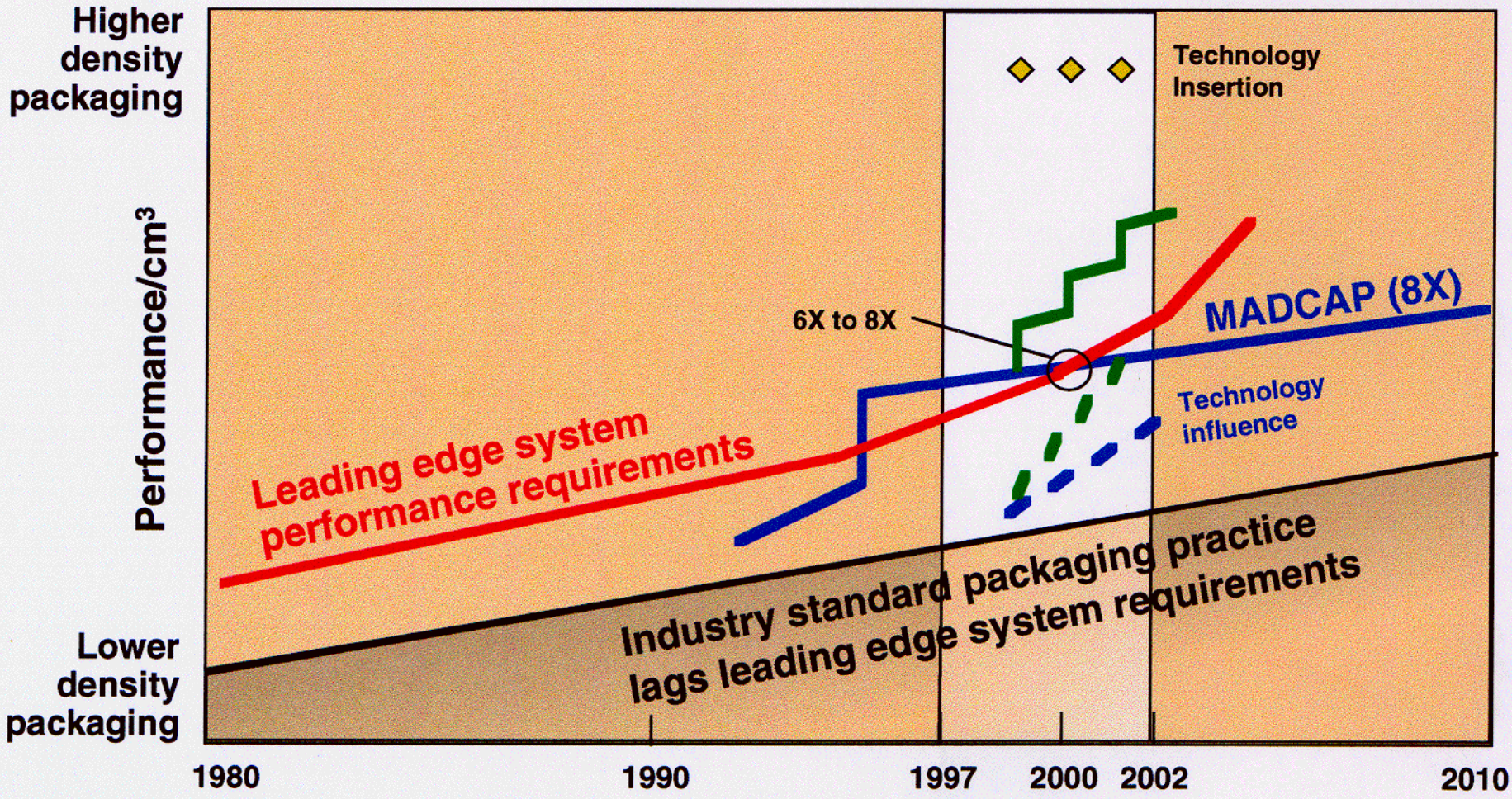
Interconnect Efficiency is Typically Poorest—
Box-to-Box and Board-to-Board

MADCAP

INTERNATIONAL SOCIETY FOR HYBRID MICROELECTRONICS

MADCAP Micro-Packaging Advances Packaging Technology Beyond System Requirements

HUGHES AIRCRAFT



MADCAP

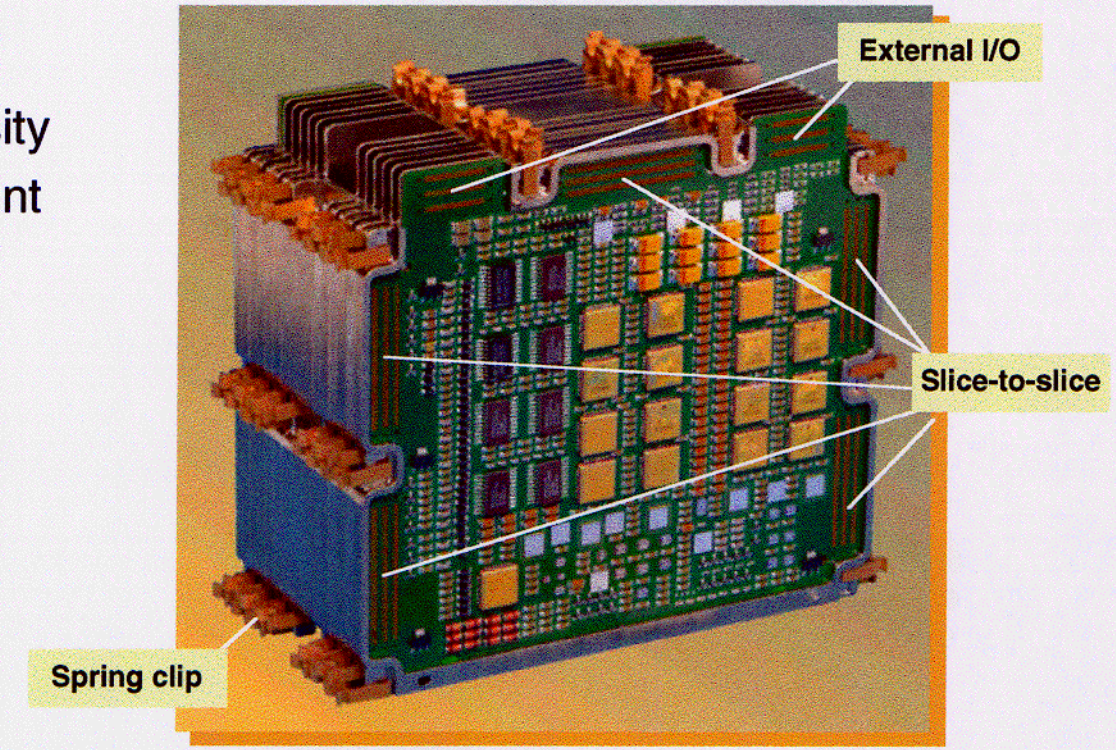
INTERNATIONAL SOCIETY FOR HYBRID MICROELECTRONICS

MADCAP 3D Slice Stack

HUGHES AIRCRAFT

- **Slice thickness adjustable from very thin (0.5 cm) to thick (2.5 cm), depending on selected parts packaging and pitch**
- **Compatible with all component packaging**
- **Key features**
  - Slices individually tested and qualified
  - Highest component density
  - Smaller baseplate footprint
  - Short path to heatsink
  - Preferential disassembly
  - Reduced assembly time

Stacked Slice Signal Processor



MADCAP

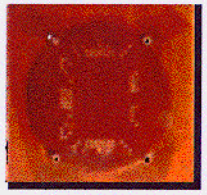
MADCAP Slice Provides A Platform for 3D Technology Development and Evaluation

HUGHES AIRCRAFT

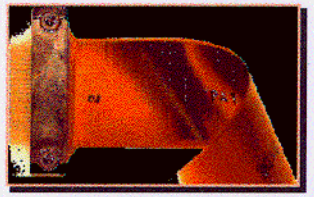
High Density Interconnects

3-D Chip Stacks

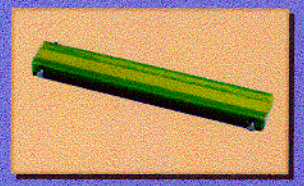
Test I/O



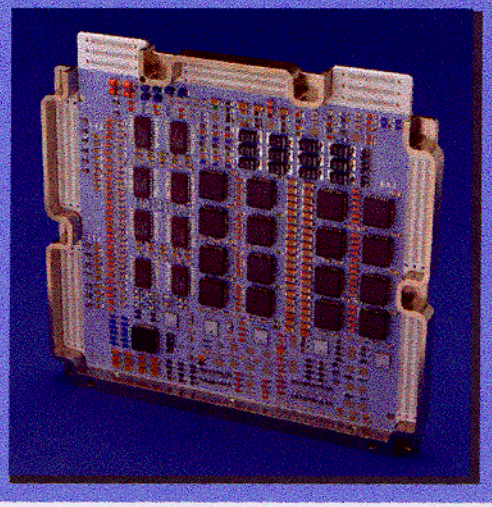
External I/O

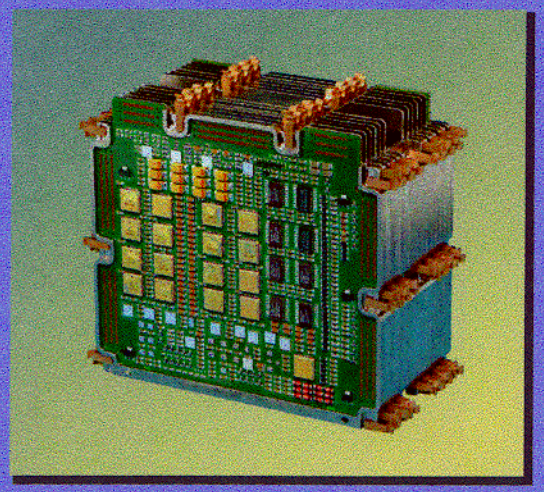


Slice I/O

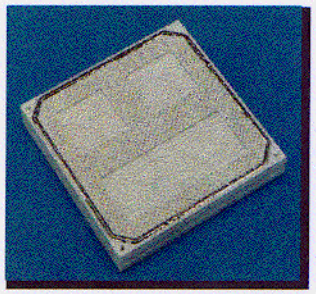


3-D Slice Stacks





3-D MCM Stacks



3-D Slices provide robust thermal/mechanical performance

MADCAP

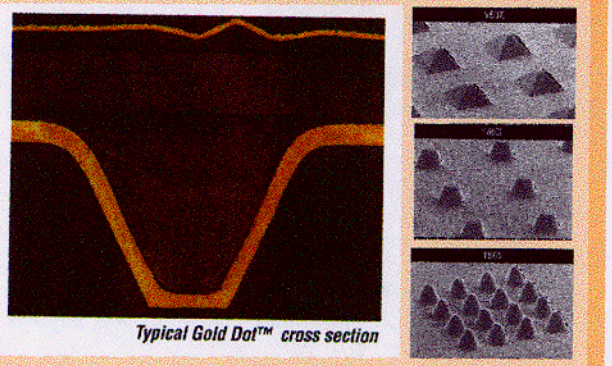
INTERNATIONAL SOCIETY FOR HYBRID MICROELECTRONICS

Gold Dot™ Pressure Contact Connectors Are Enabling Technology for 1000's I/O per Board

HUGHES AIRCRAFT

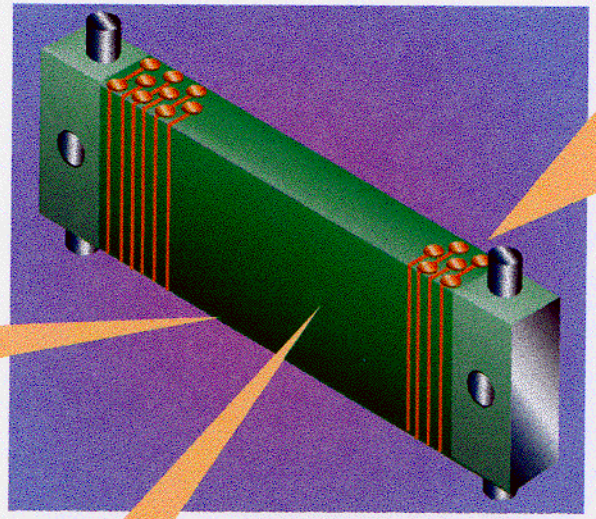
Precision Pins
- Self-aligning
- Easy insertion and removal

Gold Dot™ Bumps
- Variety of shapes
- Tight tolerance
- Production proven



Typical Gold Dot™ cross section

Springs
- High compliance
- Mass produced
- Constant Pressure



Polyimide Flexprint

Standard length:	4.8 cm
Standard width:	3 rows
Standard spacing:	0.635 mm
Variable height:	0.4 to >2.5 cm

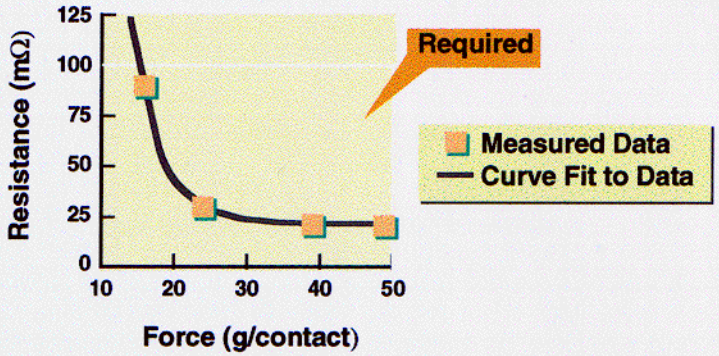
MADCAP

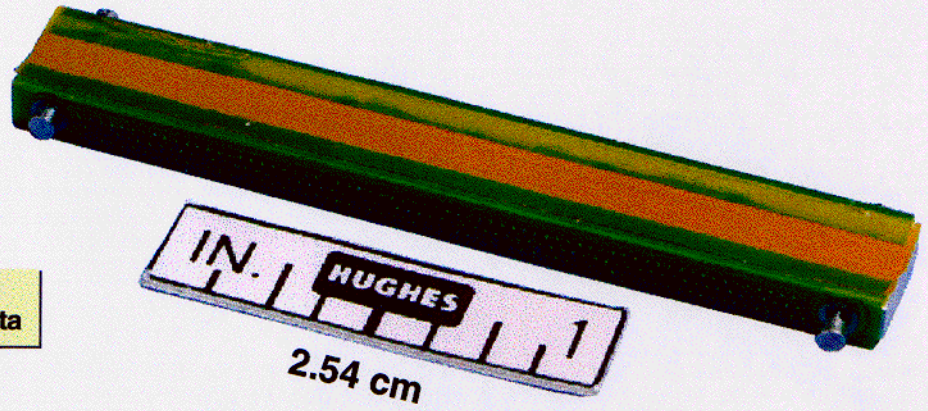
INTERNATIONAL SOCIETY FOR HYBRID MICROELECTRONICS

Gold Dot™ Pressure Contact Connectors Provide High Density and Reliability

HUGHES AIRCRAFT

- Meet required pressure loading and contact resistance with margin
- Developed for automotive; qualified for aerospace





spacing consistent with current board technologies

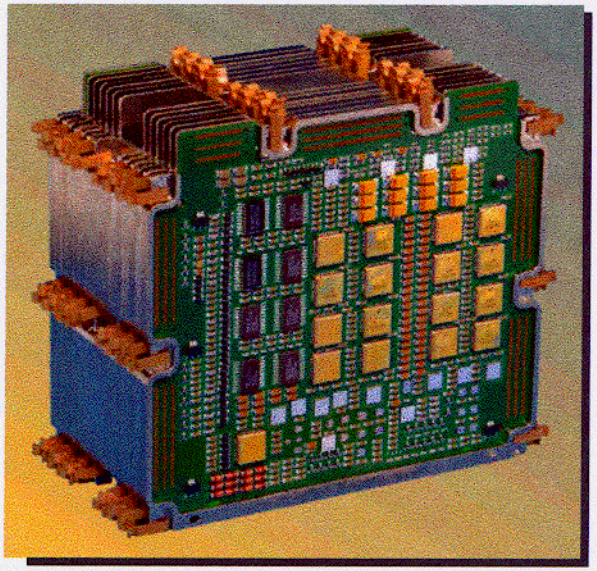
MADCAP

INTERNATIONAL SOCIETY FOR HYBRID MICROELECTRONICS

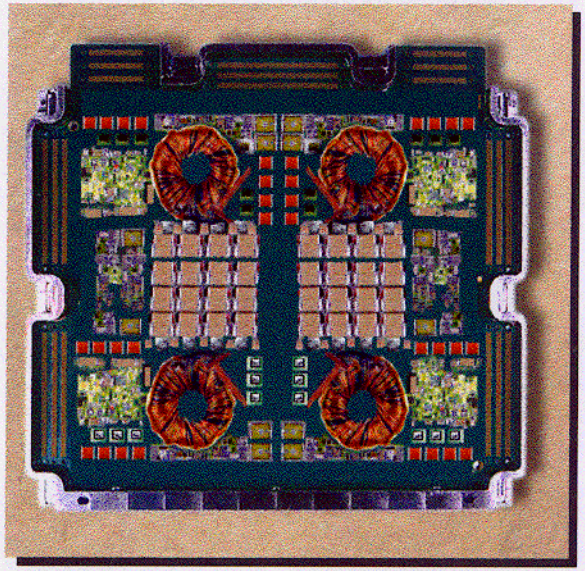
Standard Area with Variable Thickness

HUGHES AIRCRAFT

Signal Processor



Power Converters



Demonstration board size: 17 x 15 cm
650 parts/slice for signal processor
3000 slice-to-slice I/O
540 external I/O per slice

Single point regulation
1.5 to 4X decrease in magnetics
Improved performance due to shorter line lengths

MADCAP

INTERNATIONAL SOCIETY FOR HYBRID MICROELECTRONICS

High Density Interconnect Technology Enables New Architectures

HUGHES AIRCRAFT

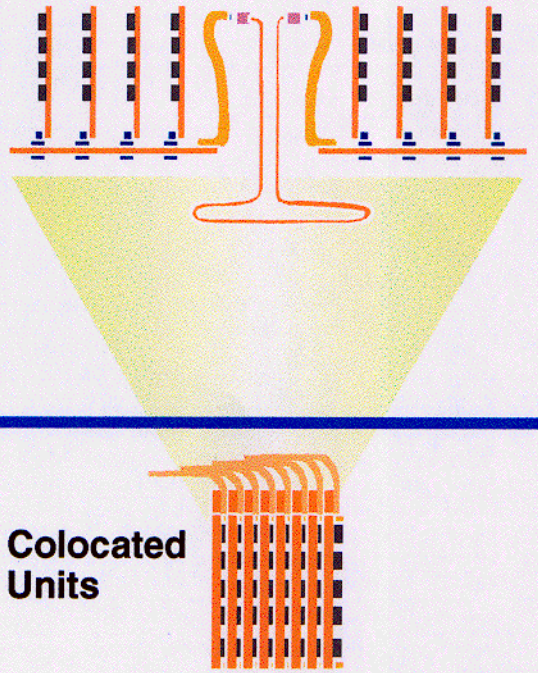
- **Traditional architecture**
  - Internal component multiplexing
  - Board-to-board multiplexing
  - Unit-to-unit multiplexing

I/O Bottleneck

Mux/Demux Penalties

- 5-40% of power
- 5-30% of size/weight
- Noise source
- Design complexity

Physically Separated Units

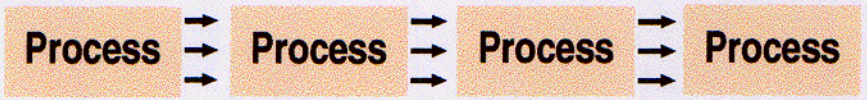


- **High density interconnect technology will**
  - Simplify design complexity and reduce cost
  - Reduce size, weight, and power
  - Colocate functions
  - Reduce mounting footprint
  - Enable insertion of intelligent adaptive processing

Colocated Units

Note text changes Here

- **Alternate architecture**
  - Highly parallel, minimal multiplexing, no backplane/internal cables

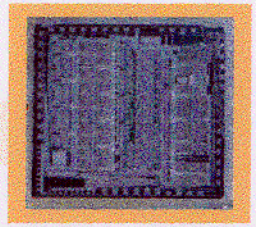


MADCAP

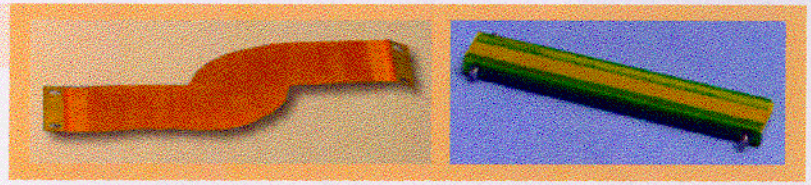
INTERNATIONAL SOCIETY FOR HYBRID MICROELECTRONICS

MADCAP Slice 3D Technologies

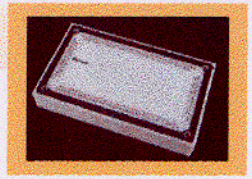
HUGHES AIRCRAFT

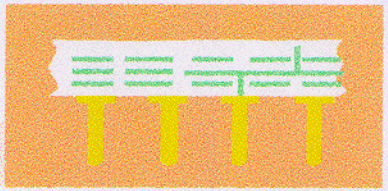


- **VLSI technology**
  - Transistor count doubles every 18 months
- **High density I/O**
  - Slice-to-slice
  - Box-to-box

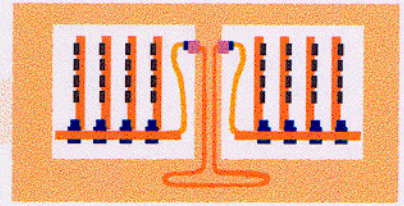


- **Small IC packages**
  - Small outline hermetic
  - Chip-on-board and chip scale packaging
  - Chip stacks
  - MCM stacks





- **Substrates**
  - Multilayer ceramics
  - Integrated resistors and capacitors
- **Architectures**



MADCAP